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  Phone: 518.276.6488

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- Refer to the Academic Calendar for important dates and deadlines.

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- Graduate Student Exit Survey
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Submitting Your Thesis

Rensselaer's Office of Graduate Education (OGE) and the Rensselaer Libraries have transitioned to an electronic-only submission process for theses and dissertations for all graduate students. This process now streamlines many of the former paper submission steps including being eco- and student-friendly!

Submission site: You will submit the electronic copy of your thesis online through UMI ETD Administrator.

No paper submission: Students are no longer required to submit a paper copy of their thesis/dissertation to OGE. Supporting documents and forms are required, however, and should be submitted to our Office. Please refer to the Dissertation/Thesis Check List for required forms that must be brought to OGE before you can upload your thesis for the final phase of the review/approval process.

- Master's Thesis Checklist
- Doctoral Dissertation Checklist

Fees, payable by credit or debit card: You will need to use a credit or debit card to pay $27 directly to UMI as part of the UMI ETD Administrator submission process. This $27 fee covers the cost of ProQuest/UMI supplying a bound paper copy of your thesis to the Rensselaer Libraries for preservation. Additional copies for personal use may also be purchased through Proquest/UMI

Please access the Preparation Guide for Dissertations and Theses for thesis guidelines and requirements. OGE's Submission Tips and Techniques (presentation slides) *OR* the Submission Tips and Techniques – Live Recording will aid you during this process as well.

Students are encouraged to make an appointment with our Office to conduct a preliminary review of a complete draft of their thesis/dissertation before final submission. For questions and/or more information, please contact the Office of Graduate Education at 518.276.6488.

In this section

- Thesis/Dissertation Manual
- Submission Savvy [Live Recording]
- Nomination of Master's Committee Form
- Nomination of Doctoral Committee
- Record of Candidacy Examination Form
- Record of Master's Thesis & Oral Presentation Form
- Record of Dissertation Exam Form
- Master's Thesis Checklist
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- Copyright and Your Dissertation or Thesis
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Doctoral thesis submission dates	
For Dec 2013	12/6/2013
For May 2014	4/18/2014
For Aug 2014	7/25/2014

Master's thesis submission dates	
For Dec 2013	11/25/2013
For May 2014	4/4/2014
For Aug 2014	7/11/2014

Before You Submit

- Review the Preparation Guide for Dissertations and Theses available on the OGE website.
- Contact an OGE staff member to conduct a preliminary review of the complete draft of your thesis/dissertation.
  - Reviews can be done in person or via email prior to your defense date.
  - General formatting revisions and reference recommendations can be made up front and may save the student time during the official review.
- Review the Doctoral or Master's Checklist on the OGE website
  - Approved forms that should already be on file: current Plan of Study, Committee form, Candidacy Examination (Doctoral students only).
  - Download or access required forms needed for submission.
- Share this information with your Advisor and Committee.
- Ask Questions & Be Proactive

Requirements

- Make sure you obtain all original signatures.
  - The Record of Master's/Dissertation Presentation Form submitted to OGE must include your citation style, have original ink signatures from your Examining Committee, and **must be dated**. A signed title page is no longer required.
- Submit your thesis/dissertation and paperwork by the deadline.
  - The length of time for reviews vary. Please submit your thesis or dissertation as soon as possible.
  - If you have successfully defended and want to start the review process early you may submit your thesis or dissertation before the deadline.
- Adhere strictly to your citation style guide and provide supporting documentation if possible or requested.
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  - References of all non-original work must be cited.
- Attribute appropriately.
  - If you have work that has been previously published, submitted for publication, or currently in press, you need to include an attribution. Please refer to the Preparation Guide for Dissertations and Theses on the OGE website for examples.

Recommendations

- Avoid contacting OGE to request an extension the week of the deadline.

- Consider using a Word or Latex template.
  - The Preparation Guide for Dissertations and Theses provides more information.

- Please keep in mind OGE is responsible for the review of all submissions. A very thorough process must be completed before a decision is made.
  - Reviewers are handling several dissertations simultaneously and try their best to complete the review process in a timely manner.

- Make any changes to the final submission requested by OGE in a timely manner.
  - 24-48 hours is an appropriate timeframe to submit any required revisions.

Common Mistakes: General

- Not being familiar with, or knowing, your citation and reference style.
  - Review your citation style guide for how journals, books, conferences, online resources, personal communications, etc. are cited and referenced.
  - Review your thesis/dissertation against your style guide before submission.

- Failing to attribute your own work.

- Inappropriately citing/referencing figures and tables from another source.
  - The reader should have sufficient information to locate the original source.
  - You may be asked whether figures and tables not cited is original work.

- Failing to make sure that your text and images are within the required margins.
  - The required margins are such that the binding side (left margin) should be no less than 1 ½ inches and the top, bottom, and outside should be no less than 1 inch.

- Inconsistency
  - Captions, font size, text alignment, capitalization, and usage of delimiters should all be consistent throughout the body of your thesis/dissertation.

Common Mistakes: References/Bibliography

Book Chapter (Chicago Manual of Style)

Incorrect Example:

J.E. Bourne. "Synthetic structure of industrial plastics," in Plastics, 2nd ed., vol. 3. J. Peters, Ed. McGraw-Hill, 1964, pp.15-67. ***(Missing location of publisher)***

Corrected Example:

J.E. Bourne. "Synthetic structure of industrial plastics," in Plastics, 2nd ed., vol. 3. J. Peters, Ed. New York: McGraw-Hill, 1964, pp.15-67.

Journal Article (2014 IEEE Style Manual)

Incorrect Example:

M. Ferris and T. Munson, Feb. 2000, "Complementarity problems in gams and the path solver," *J. Econ. Dynamics and Control*, vol. 24, no. 2, pp. 165-188.

(Date is not in the correct location)

Corrected Example:

M. Ferris and T. Munson, "Complementarity problems in gams and the path solver," *J. Econ. Dynamics and Control*, vol. 24, no. 2, pp. 165-188, Feb. 2000.

Abbreviations (Journal of the Acoustical Society of America (JASA))

Note the differences below. Some style guides, such as JASA, require the abbreviation of Journal titles. Review your style guide to determine if Journal titles should be abbreviated

Incorrect Example:

K. Kurozumi and K. Ohgushi. "The relationship between the cross-correlation coefficient of two-channel acoustic signals and sound image quality," *The Journal of the Acoustical Society of America*, **74**, 1726 (1983).

Correct Example:

A. Kulkarni and H.S. Colburn. "Variability in the characterization of the headphone transfer-function," J. Acoust. Soc. Am., **107**, 1071 (2000).

Online references (Chicago Manual of Style)

For online references, you must specify all protocols. Please list the appropriate ones (http//:, https//:, ftp, etc.) as a part of the URLs. The URL should not be underlined, a different font, or in a different color.

***Incorrect Example*:**

Barrionuevo, A. 2011. "Brazil Debates Easing Curbs on Developing Amazon Forest." *The New York Times*, May 11. Accessed 10 March 2014. www.nytimes.com/2011/05/12/world/americas/12brazil.html.

Correct example:

Barrionuevo, Alexi. 2011. "Brazil Debates Easing Curbs on Developing Amazon Forest." *New York Times*, May 11. Accessed March 10, 2014. http://www.nytimes.com/2011/05/12/world/americas/12brazil.html.

Name convention (American Institute of Physics (AIP) Style Manual)

AIP Style Manual requires author's first name initial, then full last name.

Incorrect Example:

Mittal, Gaurav., Sung, Chih-Jen, Combust. Sci. Tech. **179**, 497-530 (2007).

(Student writes last name, first name)

Corrected Example:

G. Mittal and C.J. Sung, Combust. Sci. Tech. **179**, 497-530 (2007).

Name convention (American Psychological Association (APA) Style Guide)

APA Style Guide requires full last name followed by first name initials.

Incorrect Example:

H., Harry. F. (1983). Fundamentals for preparing psychology journal articles. *Journal of Comparative and Physiological Psychology, 55*, 893-896.

(Student writes last name initial, full first name, middle initial)

Corrected Example:

Harlow, H. F. (1983). Fundamentals for preparing psychology journal articles. *Journal of Comparative and Physiological Psychology, 55*, 893-896.

Commonly Used Style Guides

- American Chemical Society (ACS)
- American Institute of Physics (AIP)
- American Psychological Association (APA)
- Chicago Manual of Style
- IEEE Editorial Style Manual
- Journal of the Acoustical Society of America (JASA)
- Modern Language Association (MLA)

If you are unsure which citation style you should be using, please consult with your Advisor or your department's Graduate Program Director.

Quorum-Sensing Repressor-Based Tools for

Cell-Cell Communication in Synthetic Biology

Thesis by

[redacted]

In Partial Fulfillment of the Requirements for the

Degree of

Doctor of Philosophy

1 Background

Light emitting diode (LED) technology is gaining acceptance as the light source for a variety of applications[1]. Energy savings, color tunability, ease of developing controls and long life times are some of the claimed advantages of this technology [2], [3]. Many innovations have immerged in the LED lighting space, utilizing many unique features of LEDs to enhance delivered value to users. Presently, the LED lighting industry defines the life as the time taken for the light level to depreciate to 70% of the initial value [4]. However, in practical applications there is no means to know when a light source has reached end of life based on this definition. Furthermore, in applications a system can reach end-of-life by ceasing to produce any light, known as catastrophic failure. Such failures are problematic in certain critical applications. In aviation, aerospace, automotive, street lighting, signaling and industrial applications, unscheduled failures of lighting systems compromise safety and increase operational costs [5], [6], [7], [8]. Therefore, an early warning methodology could improve safety, and reduce operational costs.

Such a feature built into a fixture enhances the delivered value to users of lighting systems where cost of failure and cost of maintenance is critical. The main questions is, what key parameters in an LED package can be measured in real time that could provide reliable indication that the LED package is about to fail. Therefore, the goal of this dissertation is to identify electrical and thermal parameters of an LED package that can be used for predicting failure ahead of failure while in use.

An LED lighting system is composed of many different sub-systems, such as LED packages, a thermal management system, secondary optics, and an electrical driver unit. Failure of one of these sub-systems would affect the performance of an LED lighting system. Each of these sub-systems consists of many different components. This dissertation focuses on catastrophic failure prediction of an LED package when subjected to temperature and current stress conditions.

Degradation of contacts in the LED package could lead to catastrophic failure and the probability of contact failures is significant in the reliability assessments. Further, immerging trends in LED packaging industry such as, high density packaging, high temperature rated LED packages, and high current density packages have made reliability of electrical and thermal contacts a significant concern.

Electrical and thermal parameters indicate the health of the package's electrical and thermal conduction paths. Therefore, measuring and analyzing the changes of these parameters could act as early predictors of catastrophic failure. Further, these parameters can be measured real-time within the application environment, reliably at reasonable accuracies. The systematic study of these parameters during early and late stages

Florida to Texas, much of it due to the storm surge. The most significant number of deaths occurred in New Orleans, Louisiana, which flooded as the levee system catastrophically failed; in many cases hours after the storm had moved inland [1]. Eventually 80% of the city and large tracts of neighboring parishes became flooded, and the floodwaters lingered for weeks. However, the worst property damage occurred in coastal areas, such as most Mississippi beachfront towns, which were flooded over 90% in hours, as boats and casino barges rammed buildings, pushing cars and houses inland, with waters reaching 6–12 miles (10–19 km) from the beach. The hurricane surge protection failures in New Orleans was considered by many to be the worst civil engineering disaster in U.S. history [3], and prompted a lawsuit against the U.S. Army Corps of Engineers (USACE), the designers and builders of the levee system as mandated by the Flood Control Act of 1965.

Several agencies including the U.S. Army Corps of Engineers (USACE), Federal Emergency Management Agency (FEMA), New Orleans Police Department (NOPD), United States Coast Guard (USCG), National Hurricane Center (NHC), and National Weather Service (NWS) were dealing with the hurricane. They provided accurate hurricane weather tracking forecasts with sufficient lead time; but unfortunately, even the most insistent appeals from national, state and local public officials to residents to evacuate before the storm did not warn that the levees could breach and fail. Figure 1.1 shows how critical are the levees for a city like New Orleans. Based on all different reports and investigations, it can be said that the main reason for all the mentioned damages and losses is the failure of the levees.

There are several other examples that reveal the critical role of levees and embankment dams, and their failure impact on people's lives and properties. There are nearly 14,000 miles of levees under U.S. Army Corps of Engineers (USACE) jurisdiction in US; but it does not include what is believed to be more than 100,000 additional miles of levees not covered by the Corps' safety program. Some are little more than mounds of earth piled up more than a century ago to protect farm fields. Others extend for miles and are made of concrete and steel, with sophisticated pump and drainage systems. They shield homes, businesses and infrastructure such as highways

and power plants. Figure 1.2 shows that 881 counties with a total population of 160 million in the United States are protected by levees.

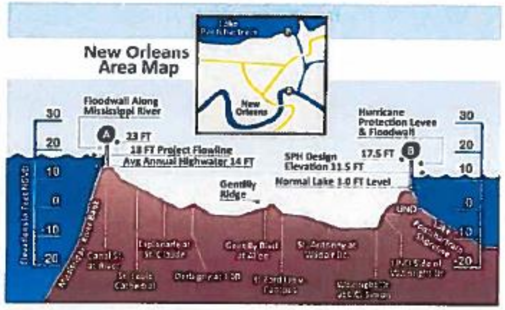

Figure 1.1: Vertical cross-section of New Orleans, showing maximum levee height of 23 feet (7 m). Vertical scale exaggerated (Image from The full wiki, [4])

Figure 1.2: United States counties protected by levees (Image from Levee.org, [5])

The national flood-control infrastructure is aging and its structural health is deteriorating. The ASCE's 2009 Report Card for America's Infrastructure gave the

In some cases, the initial stages there is no significant reaction, but after that the degradation process is rapid and can lead to catastrophic failure [48]. The slope of the Arrhenius plot determines the activation energy [47].

2.3.2 Determination of Activation energy

The rate of a first-order chemical reaction is given by:

$$k_{pd} = Ae^{-\frac{E_a}{kT}} \qquad (2.0)$$

where:

k_{pd} – Rate constant for the photo-dissociation

A – A constant related to the probability of the reaction occurring at any given temperature

E_a – Arrhenius Activation energy, usually in electron-Volts

k – Boltzmann's constant, $8.6171X10^{-5}$ electron-Volt per °C

T- Temperature in Kelvin

For an LED, the activation energy can be determined by using the failure definition, L_{70}, time for 30% decay in light output for a particular temperature. The Mean Time Between Failure (MTBF) can be written as:

$$M \quad T_0 A B^{[illegible]} \qquad (2.1)$$

where

A – Constant

E_a – Activation energy (eV) for the reaction

K_b – Boltzmann constant (0.0000861 eV/K)

T – Temperature in Kelvin (K = °C + 273)

The time constant of the degradation process decreases with increasing in temperature [48].

Previous studies have shown that the degradation rate depends on the temperature when samples were subjected to purely thermal stress [10]. In the case of white LEDs the degradation showed an exponential trend [9], [10]. Past studies have determined the activation energy to be 0.18 eV for low power LEDs and 0.92 eV for high power LEDs [10], [25], [48],[49]. The difference in the activation energy was

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1. Introduction

Today light emitting diode (LED) technology is a preferred light source in many applications such as displays, signage, and general lighting owing to its energy saving potential and reduced maintenance cost. The phosphor down conversion technique is one of the common ways to obtain white light using LED [1].

1.1 Phosphor Converted White LED

Figure 1.1 shows the basic structure of the first white LED with a phosphor layer surrounding a blue LED chip [1].

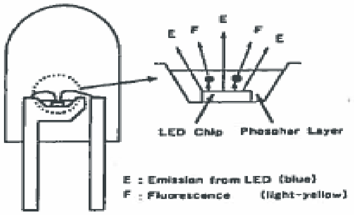

Figure 1.1 Structure of white LED [1].

The most common white LED phosphor is cerium doped yttrium aluminum garnet, $Y_3Al_5O_{12}:Ce^{3+}$; known as YAG:Ce. The emission spectrum of the pc-white LED is very broad with two peaks, near 460 nm and near 560 nm as shown in Figure 1.2.

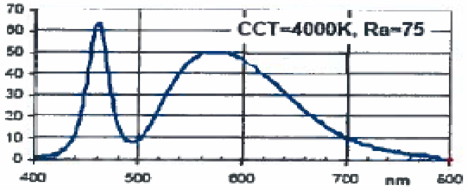

Figure 1.2 Blue LED + YAG: Ce white LED spectrum [2].

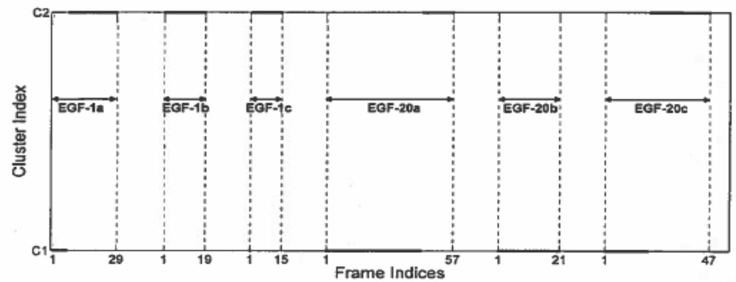

Figure 4.1: Clustering of EGF-1 and EGF-20 data sets based on morphological features. It is observed that cluster 1 is characteristic of smaller buds and shallows clefts, whereas cluster 2 is characteristic of larger buds and deeper clefts. The majority of EGF-1 data sets are present in cluster 2, whereas the majority of EGF-20 data sets are present in cluster 1. Image courtesy: Dhulekar et. al [1]

able to represent the morphological changes that occur in the SMG during branching morphogenesis. Table 2 shows multiple clustering measures including recall and precision, F-score, and entropy [34].

Table 4.1: Purity Measures for evaluating the effectiveness of clustering

	Recall	Purity	Fscore	Entropy
Cluster1	0.87	0.57	0.69	0.89
Cluster2	0.69	0.92	0.79	0.41

4.2 Control versus Treated Classification

The dataset containing twenty images each of control and treated glands was used to build a classifier that can distinguish between the two sets using both spatial and fourier domain features. The previous work on classification of the control versus treated glands by Bilgin et al.[3] used cellular and shape based features for

Portions of this chapter is to appear in: N Dhulekar, S Ray, D Yuan et al.,"Prediction of growth factor dependent cleft formation during branching morphogenesis using a dynamic graph based growth model," July 2013, submitted to *PLOS Computational Biology*

Table 4.11: Fourier based results for classifier and number of frequency regions.

Regions \ Accuracy %	Linear	diagLinear	Quadratic	DiagQuadratic	Mahalanobis
2	81.37	81.37	86.27	87.25	88.73
3	82.35	81.37	85.29	86.27	87.24
4	82.35	83.33	85.78	87.25	87.25
5	81.3	81.37	86.27	87.25	87.75

Table 4.10: Confusion matrix for shape based features with feature selection

Actual \ Predicted	Initial	Progressive	Terminal
Initial	78	7	0
Progressive	4	66	4
Terminal	0	2	43

4.3.2 Fourier coefficients based features and analysis

Fourier transform is computed on the signals for each of the three categories i.e initial, progressive and terminal. The relative energy feature is computed for different number of frequency regions after a parametric search from two to five regions.

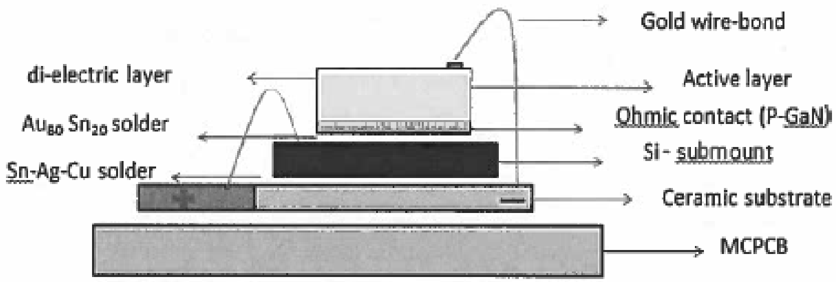

Figure 13.Schematic of the LED package

The die used in the LED package is EZ700, manufactured by CREE Inc. in USA. The maximum operating ratings of the die is given in the table below.

Table 2.The absolute product ratings as given by the manufacturer [104]

Parameter	Rating
The maximum DC current	750mA
The maximum peak current	1000mA
The maximum junction temperature	145^{0}C
The maximum Reverse voltage	5V
Operating case temperature range	-40^{0}C – 100^{0}C
Typical forward voltage at 350mA	3.5V
The reverse biased current at -5V	2μA

[53] G. G. Goyer and R. Watson, "The laser and its application to meteorology," *Bulletin of the American Meteorological Society*, vol. 44, no. 9, pp. 564-575, Sept. 1963.

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[55] A. Medina, "Three dimensional camera and range finder," U.S. Patent 5081530, Jan 14, 1992.

[56] C. S. Stuetzle, Z. Chen, B. Cutler, W. R. Franklin, J. Gross, K. Perez, T. Zimmie, "Computer simulations and physical modeling of erosion," *Proc. 7th Int. Conf. Physical Modeling in Geotechnics*, Zurich, Switzerland, 2010, pp. 1207-1214.

[57] M. Kamalzare, Z. Chen, C. Stuetzle, B. Cutler, W. R. Franklin, T. Zimmie, "Computer simulation of overtopping of levees," presented at the 2011 Pan-Am CGS Geotechnical Conf.: 14th Pan-American Conf. Soil Mechanics and Geotechnical Eng., Toronto, ON, Oct. 2011.

[58] M. Wilson. (2009, June). *Testing project natal: we touched the intangible* [Online]. Available: http://gizmodo.com/5277954/testing-project-natal-we-touch edtheintangible/. Data accessed: July 14, 2013.

[59] A. De, S. Butler, T. Zimmie. "Effects of surface explosions on top of earth embankment dams," in *Proc. Geo-Congress 2013: Stability and Performance of Slopes and Embankments III*, San Diego, CA, 2013, pp. 444- 447.

Questions?

We hope that these slides and other materials on the OGE website will assist you as you prepare your thesis/dissertation. Best of luck during this final stage!

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